Automated Traffic Density Optimization System

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Abstract. Nowadays, there is an increase in vehicle traffic everywhere, particularly in cities. In the future, intelligent traffic control will become a critical issue as the number of road users continues to rise. Traffic congestion is starting to become a major problem. Many cars are stuck at traffic signals for extended periods of time, which increases human time consumption and causes numerous issues for those who commute to work and for business purposes. The current system does not regulate traffic in accordance with density and does not lessen the impact of traffic in urban areas. Nowadays, there is an increase in vehicle traffic everywhere, particularly in cities. So by using image processing based on the density the signal will display along with the timer and also has the priority for the emergency vehicles.

1 . Introduction:

Traffic-jam is a very big problem in developing cities, In fact it's ever increasing day-by-day nature makes it difficult to find where the traffic density is more in real time, so that to schedule a better traffic signal control and effective traffic routing. The root cause of this can be of different situations like congestion in traffic like insufficient Road width, Road conditions due to weather, unrestrained demand, large delay of Red Light etc. While insufficient capacity and unrestrained demand are somewhere interrelated, the delay of respective light is hard coded and not dependent on traffic. Indeed, manual control is must, Therefore, in order to reduce man's power, the need for simulating and optimizing traffic control to satisfy the increasing demand arises. Technology in the recent past using image processing for surveillance and safety, which is widely used in vehicle and traffic management for traveler information. The traffic density estimation can also be achieved using Image Processing. Traffic congestion poses a significant challenge in the urban development landscape, particularly in growing cities. The issue is exacerbated by its continuous escalation, making it challenging to pinpoint real-time high-density traffic areas for efficient traffic signal control and routing. Various factors contribute to this problem, including insufficient road width, adverse weather conditions affecting road conditions,

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unmanaged demand, and prolonged red light delays. The relationship between insufficient capacity and unregulated demand further complicates the situation. The fixed timing of traffic lights, irrespective of traffic conditions, adds to the complexity. To address this predicament and reduce dependence on manual intervention, there is a pressing need for simulating and optimizing traffic control to meet the rising demand. Recent technological advancements have leveraged image processing for surveillance and safety purposes, gaining widespread application in vehicle and traffic management for providing traveler information. Employing image processing techniques allows for the estimation of traffic density, offering a potential solution to the ongoing challenges associated with traffic management. An embedded system constitutes a blend of computer hardware and software, often accompanied by additional mechanical or other components, with the specific purpose of executing a designated function. Consider the microwave oven as a prime example, a ubiquitous appliance in households globally. While millions utilize it daily, many are unaware that it involves a processor and software in the preparation of meals.

1.1 Problem Statement

The current traffic management system faces challenges in efficiently regulating traffic flow, leading to increased congestion, accidents, and wasted resources. Conventional methods rely on preset timers or electronic sensors in the pavement, which may not accurately reflect real-time traffic conditions. This lack of adaptability contributes to longer waiting times, increased fuel consumption, and higher accident rates. The problem statement involves the inadequacy of current traffic management systems in adapting to real-time conditions, resulting in congestion, accidents, and inefficiencies. Our solution proposes an intelligent image processing approach to dynamically control traffic lights based on actual traffic density, with the ultimate goal of enhancing road safety, reducing fuel consumption, and optimizing traffic flow.

2 Literature Survey

W. A. C. J. K. Chandrasekara, L. L. G. Chathuranga published "A Real-Time Density-Based Traffic Signal Control System" in the International Conference on Information Technology Research in 2020.Traffic congestion, accidents, and travel time delays are the main problems in cities. Traffic congestion, environmental pollution, and economic issues are all made worse by automated traffic control systems. This system uses cameras that monitor lanes and an image processing model to collect data and photos in real time. The quantity of cars is included in the data. Based on this visual data, an Artificial Neural Network (ANN) model trained with features chosen by principle component analysis (PCA) forecasts the outcome[2]. The International Conference on Electrical, Communication, and Computer Engineering, 2020 featured a paper on "Development of congestion level based dynamic traffic management system using IoT" written by Mansoor Akhtar, Muhammad Raffeh, and Fakhar ul Zaman.The current static traffic management system is causing an increase in traffic, pollution, and fuel consumption. One suggested remedy is a dynamic traffic management system based on the Internet of Things. The scenarios of congestion found by simulations serve as a guide for the development of logic frameworks. The Internet of Things system uses ultrasonic sensors to measure traffic at intersections in real time. This information is used by a responsive network to adjust traffic light timings. The prototype aims to effectively tackle traffic-related issues in cities in real-time [3].The current static traffic light systems waste energy and cause delays because they rely on offline data. This study proposes a dynamic system that uses machine learning, specifically convolutional neural networks (CNNs), to estimate traffic density in real time at four-way intersections. The goal is to reduce traffic bottlenecks caused by poorly designed algorithms and poorly planned infrastructure. The dynamic approach aims to enhance overall traffic flow while reducing delays and energy consumption by precisely estimating traffic density[5]. The operational and financial inefficiencies of the current manual traffic management system result in increased traffic and accidents on the roads. One proposed solution to these issues is a smart traffic system that uses infrared sensors and Arduino to minimise delays and congestion. The system improves overall traffic flow and reduces the likelihood of traffic bottlenecks by efficiently managing traffic. Including a renewable energy source ensures low power consumption for continuous operation, such as solar panels.This smart density-based traffic system aims to drastically cut down on delays at traffic intersections by using real-time data from infrared sensors. It provides a practical and sustainable solution[4] Shanta Rangaswamy, Datthesh P. Shenoy, and Roopa Ravish "Sensor-Based Traffic Control System" . The 2019 Global AI Congress Proceedings. Volume 1112 of Advances in Intelligent Systems and Computing.The current road traffic control systems have a hard time preventing accidents and maintaining constant traffic flow. A contributing factor to inefficiencies is the lack of a dependable system for regulating traffic signals according to the real density of vehicles. This paper proposes a technique that uses two distinct systems to control traffic flow in order to address these issues. The first system collects vehicle density data in each lane using ultrasonic sensors, and the second system uses this data to dynamically adjust traffic signals[1]. Sujit.H.Ramachandra,K.Nitesh.Reddy,Vivek.R.Vellore published a paper on “A Novel Dynamic Traffic Management System using On Board Diagnostics and Zigbee Protocol” international Conference on Communication and Electronics Systems in 2016.A novel system is proposed that aims to control traffic lights dynamically and leaves room for more applications based on vehicle-to-vehicle and vehicle-to-infrastructure communication. The project's goal is to create and put into practice a functional prototype of a system that will reduce traffic congestion by dynamically adjusting traffic lights in response to traffic density, which is calculated using average speed data supplied by the cars. Each car will have a central unit that uses an OBD device to gather speed data (including average speed) from the onboard sensors[7]. Paul Jasmine Rani, Khoushik Kumar published a paper on "Dynamic Traffic Management System Using Infared and Internet of things" Third International Conference on Science Technology Engineering & Management,2017 The project's main objective is to use image processing, infrared sensors, and the Internet of Things to enable dynamic traffic management systems that operate effectively. The goal of traffic management automation systems on the market is to computerise traffic lights. These systems use multiple technologies, such as GSM and NFC, to control the light (red, yellow, or green) on a periodic schedule. They also concentrate on the fundamental functions of an electrical switch. Our project's goal is to offer an automated IR-sense-based system that enables traffic signals to dynamically change from red to yellow to green. Our goal is to implement the project for one June "Proof-of Concept" for this paper, which consists of a Raspberry Pi micro-controller, traffic lights, IR sensors, and a Wi-Fi transmitter[8]. Two typical situations involving microscopic dynamic traffic management are assessed in this work. By meddling in the actions of one or a few drivers, Microscopic Dynamic Traffic Management anticipates suboptimal use of the infrastructure that is already in place, while Dynamic Traffic Management aims to maximise the use of the current road capacity through general measures. When slow vehicles merge from an on-ramp and slow predecessors in the same lane are predicted using simulation, throughput, average travel time loss, and traffic flow stability are assessed. The results of the simulation show that when slow-merging vehicles are anticipated, there are positive effects on throughput, travel time, and traffic flow stability.Winnie Daamen and Bart van Arem released a paper titled

"Simulating microscopic dynamic traffic management in two typical scenarios[9]. The rapid development of road infrastructure leads to an increase in the number of vehicles on the road network, which in turn causes traffic congestion. The same thing is true in the Sultanate of Oman. Traffic congestion is a major problem for Muscat and the other cities in the Sultanate of Oman. This is mostly caused by the sudden and significant rise in the number of vehicles.[10] To lessen the effects of traffic congestion, an IoT-based traffic control system must be developed. The proposed system would be based on the actual traffic density on the route. To do this, real-time video techniques and image processing would be applied. Given the speed at which road infrastructure is developing, the volume as the number of vehicles on the road network rises, causing traffic congestion. In the Sultanate of Oman, the same situation occurs. One of the biggest issues Muscat and other Sultanate of Oman cities face is traffic congestion. This is mostly brought on by the quick increase in the number of vehicles in a brief period of time. The development of an IoT-based traffic control system is necessary to mitigate the effects of traffic congestion. The real traffic density on the route would serve as the foundation for the suggested system. Image and video processing methods in real time would be used to accomplish this [11]..

3 Methodology

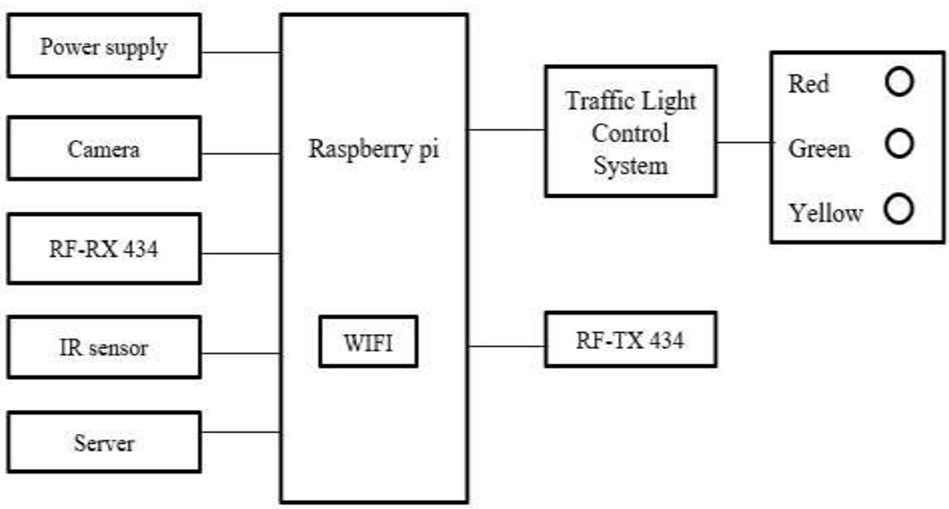

Fig.1. Block diagram of Automated traffic density optimization system

Fig.1. depicts the traffic management system employs background substitution to initialize and capture images, isolating and tracking moving vehicles crossing the camera module. Integrated with a Raspberry Pi sensor, the camera precisely estimates vehicle movements. Utilizing this data, the system calculates the count of vehicles that have crossed the camera's field of view, providing a real-time assessment of traffic density. The captured information is then relayed to the traffic signal system, which dynamically adjusts signal timings based on the density metrics. In instances where the vehicle count surpasses a predefined threshold, indicative of high traffic density, the system triggers a green signal to facilitate the smooth flow of vehicles. Conversely, during periods of lower density, the traffic signal switches to red, effectively regulating the traffic flow. This adaptive control mechanism ensures that the traffic signal responds intelligently to the changing conditions on the road, promoting efficient and safe traffic management. The integration of

background substitution, Raspberry Pi sensors, and dynamic signal control collectively contributes to a responsive and data-driven approach to traffic management.

4 Hardware description of the proposed system

W. A. C. J. K. Chandrasekara, L. L. G. Chathuranga published "A Real-Time Density-Based Traffic Signal Control System" in the International Conference on Information Technology Research in 2020.Traffic congestion, accidents, and travel time delays are the main problems in cities. Traffic congestion, environmental pollution, and economic issues are all made worse by automated traffic control systems. This system uses cameras that monitor lanes and an image processing model to collect data and photos in real time. The quantity of cars is included in the data. Based on this visual data, an Artificial Neural

4.1 Raspberry PI: The BCM2837 controller, which supports the ARM11 processor unit, is found on a Raspberry Pi 3 board. The Raspberry Pi 3 and later Raspberry Pi 2 models both use this Broadcom chip. The BCM2837 and BCM2836 share the same underlying architecture. The ARM Cortex A53 (ARMv8) quad-core cluster has replaced the ARMv7 quad-core cluster, which is the only notable change.The device is approximately 50% faster than the Raspberry Pi 2 due to its ARM cores operating at 1.2GHz. At 400 MHz, the Video core IV operates.With a faster processor on board to boost speed, the Raspberry Pi 3 Model B improves upon the features of its predecessors. To improve functionality and enable the USB ports to power more powerful devices, it also has WiFi and Bluetooth Low Energy capabilities.On board, there is a quad core 1.2GHz Broadcom BCM2837 64-bit CPU, 1GB RAM, 40 pin Extended GPIO, 4x USB 2 ports, 4 Pole stereo output and composite video port, Full size HDMI, CSI camera port for connecting a Raspberry Pi camera, DSI display port for connecting a Raspberry Pi touchscreen display, and Micro SD port for storing data and loading your operating system.

4.2 Camera: A webcam is a tiny digital video camera that can be either directly or indirectly linked to a computer, computer network, or computer.Users of webcams can record or stream video to the Internet by installing the software that comes with the device on their computer. High-definition videos can be recorded with webcams, though the quality of the videos may not be as good as it could be when compared to other camera models.Another name for webcams is web cameras. An input device that takes digital pictures is a webcam. They are moved to a server by the computer after being transferred there. They can then be sent to the hosting page from there PCs and laptops frequently have webcams installed.

4.3 LEDs: When current passes through a light-emitting diode (LED), a semiconductor light source, light is released. Photons are released as a result of the semiconductor's electrons and electron holes recombining. The energy needed for electrons to cross the semiconductor's band gap determines the colour of the light, which is correlated with photon energy.[5] Using multiple semiconductors or covering the semiconductor device with a layer of light-emitting phosphor allows for the production of white light. The first LEDs were practical electronic components that emitted low-intensity infrared light in 1962. Remote-control circuits, like those found in a wide range of consumer electronics, employ infrared LEDs. The first LEDs that produced visible light were dim and only produced red light. High light output LEDs are now widely available in the visible, ultraviolet, and infrared spectrums. Initially, seven-segment displays and indicator lamps (which were essentially tiny incandescent bulbs) were frequently equipped with LEDs. High-output white light LEDs that are suitable for lighting outdoor spaces and rooms have been made possible by recent developments. LEDs' high switching rates are helpful in cutting-edge communications technology, and they have produced new displays and sensors.

5. Conclusion

We conclude the Density measurement by using opencv tool as software for image processing by just displaying the various conversion of image in the screen and finally surrounding the box on the vehicle in the given image, the number of vehicle is calculated. We can calculate the density of the vehicle by using mat lab tool by comparing the four side of the image which is given as a input. we can simulate the result of the four given input image but this cannot be used in real time applications as it is very slow and the software is not free of cost like opencv to overcome this disadvantage of mat lab, opencv software is used which is very easy to install and is open source software and can be used in real time

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